

Office of the Chief Scientist for Human Factors

Human Factors Aviation Maintenance

Program Review
FY01



Dr. William K. Krebs, Aviation Maintenance Human Factors Program Manager

Federal Aviation Administration
AAR-100 (Room 907A)
800 Independence Avenue, S.W.
Washington, D.C. 20591
phone (202) 267-8758
e-mail: william.krebs@faa.gov
<http://www.hf.faa.gov/krebs>

The Federal Aviation Administration Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) directs an aviation maintenance human factors program that focuses on identifying human factors issues across all aspects of aircraft maintenance and inspection personnel. The Aviation Maintenance research program has maintained a focused research approach in four major components – skill development, organizational influences, human error, and maintainer proficiency.

The following report lists projects between October 1st, 2000 and December 31st, 2001 (Appendix I). These projects address requirements identified by the Federal Aviation Administration Flight Standards office (Appendix II). The intent of this report is to allow Federal Aviation Administration sponsors to determine whether their requirements have been satisfactorily addressed, allow investigators to receive feedback from Federal Aviation Administration sponsors and other interested parties, and to provide feedback to the AAR-100 aviation maintenance program manager on the quality of the research program. Basically, this document is a means of holding each group (sponsor, investigator, AAR-100 program manager) accountable to ensure that the program is successful.

In FY01, the aviation maintenance research program distributed \$1,039,890 contract and grant dollars to multiple organizations. In addition, one project received supplemental support from the Civil Aerospace Medical Institute, Oklahoma City, OK. These FY01 projects are described in Appendix I and the requirements that are mapped to these projects are located in Appendix II.

Appendix III lists the FY02 funded projects (~ \$1,000,000 contract dollars) and the proposed FY03 and FY04 projects.

Address questions or comments to:

William K. Krebs, Ph.D.

Appendix I

Human Factors Aviation Maintenance

FY01 Funded Projects

**FY01 Aviation Maintenance
Funded Projects (\$1,039,890)**

Task	Performer	Anticipated Deliverable	Requirement # and page #
Evaluation of the Integrated AMT/AMT-T Curriculum Alternative Method of Compliance Implementation & Assessment	Greenville Tech/Clemson	Validation/Report/Guidance/Congress Mandate	Req #177 Page #19
Human Error Risk Analysis in Maintenance and Flight-line Operations (HFACS-ME)	NASA/Navy	Risk Analysis	Req #28 Page #11
Impact of Professional, Organizational & National Culture on Safety in Aviation Maint. Environment (Phase 2 & Phase 3)	NASA/Santa Clara University/San Jose State	Development of profiles/elements of safety culture	Req #173 Page #15
Root Cause Analysis of Rule Violations by AMT's	San Jose		Req #170 Page #13
Reducing FOD Through Improved Human Performance: Best Practices	Galaxy	Develop recommendations/corrective actions	Req #169 Page #12
Application of Human Factors Interventions to Improve Inspection Performance	Clemson University	Development of Prototype Inspection Aid	Req #183 Page #21
Evaluation of AMT Working Environments,	Galaxy	Report and regulatory guidelines	Req #172

Fatigue, Human Performance and Maintenance Errors/Incidents/Accidents		(Audit)	Page #14
Development of AMT Apprenticeship/OJT Standards	AT&T/Purdue	Standards/Guidance Material	No requirement
Info Dissemination & Technology Transfer	Galaxy	Cumulative phase reports, position papers, etc/web/cd-roms/support for sponsor requirements	
FAA/CAA/Transport Canada MX HF Workshop	Galaxy	Continuing support of FAA/CAA/Transport Canada conferences on Maintenance Human Factors	

Appendix II

Human Factors Aviation Maintenance Research Requirements

Research requirements exist in the AAR-100 interactive management database that allows program managers to track research requirements for each Federal Aviation Administration sponsor.

FY Request	Research Requirement	Page #
< FY02	<i>Proactive Safety Assessment</i>	<u>8</u>
< FY02	<i>Measuring the Effectiveness of Error Investigation and Human Factors</i>	<u>9</u>
< FY02	<i>Reducing Installation Errors in Heavy Maintenance</i>	<u>10</u>
< FY02	<i>Human Error Risk Analysis in Aviation Maintenance and Flight-line Operations</i>	<u>11</u>
< FY02	<i>Reducing FOD through Improved Human Performance: Best Practice</i>	<u>12</u>
< FY02	<i>Root Cause Analysis of Rule Violations by AMT's</i>	<u>13</u>
< FY02	<i>Evaluation of Aviation Maintenance Working Environments, Fatigue and Maintenance Errors/Accidents</i>	<u>14</u>
< FY02	<i>The Impact of Professional, Organizational, and National Cultures on the Safety Climate in the Aviation Maintenance Environment</i>	<u>15</u>
< FY02	<i>Development of the AMT Training Models</i>	<u>16</u>
< FY02	<i>Optimizing Maintenance Technician Training and Certification</i>	<u>17</u>
< FY02	<i>Development of Standards for AMT Certification Training Using Distance Learning</i>	<u>18</u>

< FY02	<i>Evaluation of the Integrated AMT/AMT-T Curriculum Alternative Method Implementation and Assessment</i>	<u>19</u>
< FY02	<i>Evaluation of US Military AMT Training and Experience Applicability to Training, Qualification, and Certification Requirements</i>	<u>20</u>
< FY02	<i>Application of Human Factors Interventions to Improve Inspector Performance</i>	<u>21</u>
< FY02	<i>Human Factors Best Practices in Engine Inspection</i>	<u>22</u>
< FY02	<i>Development of Handbook of Human Factors in Airframe and Engine Inspection Reliability</i>	<u>23</u>
< FY02	<i>General Aviation Maintenance Human Factors: Taxonomy of Human Error At-Risk Conditions in General Aviation Maintenance</i>	<u>24</u>
FY02 “pop up”	<i>Demonstration Project for AMT Training Delivered Using Distance Learning Technology: FAR 147 Certification Model; Structured Experience Certification Model; AMT Recurrent Training Model</i>	<u>25</u>
FY02 “pop up”	<i>Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components</i>	<u>26</u>
FY02 “pop up”	<i>Assessment of FAR PART 145.159 Repair Stations - Training Requirements for maintenance production and supervisory employees with Summary Recommendations</i>	<u>28</u>
FY02 “pop up”	<i>Assessment of Requirements for and Availability of Qualified Aviation Maintenance Technicians by 2005</i>	<u>29</u>
< FY02	<i>Increase Reliability of Wiring Inspection</i>	<u>30</u>
< FY02	<i>Development of Best Practices for Confined Space Work</i>	<u>32</u>
FY04 Task	<i>Evaluation of Broadband Applications to Aircraft Maintenance Safety</i>	<u>36</u>
FY04 Task	<i>Using Technology to Support Inspection Training: In the General Aviation Industry</i>	<u>37</u>

Requirement ID: 25

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Proactive Safety Assessment

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Assess error generation to more effectively assess the propensity for future errors within maintenance organizations and allocate organizational resources in their prevention. Current methods utilized within airline maintenance industry are restricted to reactive measurement of error causation.

Background: Develop methodologies similar to those used effectively in the nuclear and chemical industries to assess organizational factors and latent conditions which cause the majority of errors within aviation maintenance

Output: Development of generic audit system which indicate organizational factors and latent conditions which predict potential maintenance errors that could be implemented by various maintenance organizations.

Regulatory Link: AOA Performance Plan (2000) G-1.0.1.h /FAA Strategic Plan (2000) Initiative 47: A ASAP AC 120-66/FAA National Aging Aircraft Program Plan

Requirement ID: 26

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Measuring the Effectiveness of Error Investigation and Human Factors

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Reduce errors in aviation maintenance and test effectiveness of human factors interventions. Measure how thoroughly airline maintenance personnel investigate errors or incidents and measure the effectiveness of Human Factors interventions using an error-investigation methodology.

Background: Incident-based methodology to test effectiveness of human factors interventions. Effectiveness is measured by how thoroughly airline maintenance personnel investigate errors or incidents. Baseline data will be collected on samples of professional investigators (Quality Assurance investigators, human factors professionals, aviation maintenance managers and foreman, and AMTs). Measure how skilled these groups are and what bias they show.

Output: Specific measures of how training programs and the investigation tools provide usable knowledge to the investigators

Regulatory Link: AOA Performance Plan (2000) G-1.0.1.h, FAA Strategic Plan (2000) Initiative 47: AASAP AC 120-66, NTSB interest FAA National Aging Aircraft Program Plan

Requirement ID: 27

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Reducing Installation Errors in Heavy Maintenance

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Use applied research to reduce a selected category of error by 50%. Show that FAA research can offer cost effective and quantifiable solution

Background: Creation of specific actions and interventions to be used by the aviation maintenance industry to reduce errors of omission.

Output: A listing of interventions to minimize human error in installation during maintenance and inspection. A report showing the percent of error reduction achieved.

Regulatory Link: NTSB Recommendation 89-56/FAA National Aging Aircraft Program Plan

Requirement ID: 28

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Human Error Risk Analysis in Aviation Maintenance and Flight-line Operations

Funded Requirement:

- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Current systems to capture human error in aviation maintenance have mixed reviews. Most focus on proximate causes and immediate circumstances, while others use a task analytic approach to examine distal events. However, these approaches do not uncover all of the “latent conditions” such as teamwork or inadequate supervision that effectively “set the stage” for “active failures” to occur. Furthermore, they do not provide for human error risk assessments based upon exposure, severity of outcome, number of operations, etc.

Background: A taxonomic framework suitable for use as a training vehicle, investigator reference, database structure, etc. An analysis of a range (major to minor) of Part 121 organizational mishaps obtained from the commercial airlines, rework facilities, transient lines, etc. A documented risk assessment process suitable for Part 121 organizations. A human factors risk assessment for problems identified in the Part 121 analyses

Output: This research will provide a multi-dimensional framework to support the investigation, reporting, and analysis of commercial aviation maintenance incidents. It will also generate a process to identify human factors problems, determine present trends, and estimate associated risks in commercial aviation.

Regulatory Link: AOA Performance Plan (2000) G-1.0.1.h, FAA Strategic Plan (2000) Initiative 47: ASAP AC 120-56, FAA National Aging Aircraft Program Plan

Requirement ID: 169

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Reducing FOD through Improved Human Performance: Best Practice

Funded Requirement:

- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: A recent initiative was undertaken by industry to identify and rank potential catastrophic events contributed by human error (9/99). The survey ranked Foreign Object Damage (FOD) as the most potential cause that could lead to a catastrophic event. FOD accounts for a significant amount of industry costs. Boeing estimates yearly FOD costs to exceed \$4 billion. Though some research has been performed that examined human factors precursors to ground damage, relatively little effort has been dedicated to organizational-level (organizational culture) precursors of FOD.

Background: Address that gap by identifying potential contributory root cause factors that lead to FOD.

Output: Establish a baseline for further human factors investigations related to FOD through root cause trending tailored to cultural preconditions.

Regulatory Link: ATA/ATA Maintenance HF Subcommittee/Research Task Force data: Project not continued after 2001

Requirement ID: 170

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Root Cause Analysis of Rule Violations by AMT's

Funded Requirement:

- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: The FAA enforcement action data for the first three quarters of 1999 shows that 79 certificate actions resulted in approximately \$2.25M of fines due to maintenance violations. Such certificate actions are usually initiated by a letter of investigation (LOI) issued to the mechanic responsible for the maintenance action that potentially impact the airworthiness of the aircraft being maintained which could lead to an incident or accident. From that point forward, substantial resources from the FAA and the industry are spent in these investigations. The research focuses on the causal factors for alleged rule violations by AMTs. Such analysis is expected to identify individual and organizational factors that lead to incidents or accidents in the future. This is a proactive approach to identify root causes or latent systemic failures early enough so that serious mishaps are avoided. By focusing on the rule violations, the most significant root causes are addressed, making change implementation more safety oriented and cost effective.

Background: Detailed analysis of the individual and organizational factors contributing toward rule violations by AMTs. The mapping of root causes of these violations will provide the FAA and airlines with specific target areas for improvement.

Output: Identification of the most significant factors that are responsible for rule violations. Develop appropriate guidelines that will manage and mitigate these factors and reduce the instances of rule violations.

Regulatory Link: FAA AFS Enforcement (E.I.R.)/FAA National Aging Aircraft Program Plan

Requirement ID: 172

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Evaluation of Aviation Maintenance Working Environments, Fatigue and Maintenance Errors/Accidents

Funded Requirement:

- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Few regulations govern the working environments of aviation maintenance personnel. Unlike the uniformity of the cockpit environments, aviation maintenance workers perform their tasks in a wide variety of environmental conditions. Some of these conditions have been found to accelerate the onset of fatigue, decrease job performance, and increases human error and the risk to aviation safety. Profile AMT task environments and model data to predict conditions that are related to aviation maintenance errors.

Background: Develop methods and guidelines that can be used to reduce fatigue producing factors in the aviation maintenance environment that will reduce maintenance errors/accidents and increase maintenance safety.

Output: Fatigue profile model related to risk management of aviation maintenance errors. This model will be written in a report and lead to regulatory guidelines (Audit).

Regulatory Link: NTSB recommendation A-97-71/Petition for rulemaking/GAO report/Intermodal/AOA Performance Plan G-101.f/AVR Performance Plan (2000)/FAA National Aging Aircraft Program Plan

Requirement ID: 173

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: The Impact of Professional, Organizational, and National Cultures on the Safety Climate in the Aviation Maintenance Environment

Funded Requirement:

- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Significant research needs to be accomplished on developing the concepts and measurements of “professionalism” and mutual trust in a professional environment because it is postulated to be the key in building safe virtual organizations. Such measures must transcend the traditional boundaries of national and organizational cultures not only because aviation is an international business, but also because AMTs in the United States are multiethnic.

Background: Currently, it is known that differences in professional, organizational, and national cultures exist in aviation maintenance. Their inter-relationships and the consequent effect on the overall safety culture are not known. This research will provide a further understanding of the concept of “safety culture” in aviation maintenance and identify the positive and negative influences on that culture.

Output: Development of profiles of the safety culture at the maintenance facilities of major U.S. airlines. These profiles will constitute professional, organizational, and national attributes which contribute to safety culture. The inter-relationships and effects of changes in the constituent elements on the safety culture will be explored.

Regulatory Link: Safety/NTSB/MRM follow-on AVR Performance Plan (2000)
Initiative 34/FAA National Aging Aircraft Program Plan

Requirement ID: 174

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Development of the AMT Training Models

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Training requirements for the AMT were developed in 1968. Except for minor revisions in 1993, these requirements have remained unchanged. Technological advance in aircraft, power plants and their systems have vastly outpaced the training requirements for entry-level AMTs. This gap has created problems for the aviation industry in finding adequately trained technicians.

Background: Specific student performance objectives (SPOs) to correspond to curriculum topics

Output: Develop curriculum models for the A&P schools and AMT's for highly skilled workforce and develop performances level to meet requirements to work on newer more advanced aircraft. This will lead to the development of a distance learning standard (Eval & Validate)

Regulatory Link: Regulatory FAR Part 147; AVR Performance Plan(2000) Initiative 35, NTSB Recommendation A-89-56/FAA National Aging Aircraft Program Plan

Requirement ID: 175

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Optimizing Maintenance Technician Training and Certification

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Technician training and certification has not kept pace with the requirements of the industry, the FAA sponsored an ARAC project to revise the regulation, the process continued for over 8 years and resulted in an NPRM that the industry generally believed was too complex and not workable. CFR 14 PART 65 underwent regulatory revision that resulted in an NPRM issued November 1998. The NPRM received more than 2000 comments, mostly negative, commenters primarily objected to the NPRM complexities, the amount of regulatory requirements contained in advisory material a two tier technician certification system, and the amount of training specified for technicians. The FAA has three objectives in technician certification, conduct a recurring census of technicians, increase the training and certification requirements, and focus on air transportation issues. The FAA requires a study to achieve those objectives without introducing the significant complexities that developed in the original NPRM.

Background: The desired outcome would be a study that would provide appropriate background to FAA to develop a realistic regulation in accord with the majority of comments and achieve the FAA certification goals.

Output: Report detailing various options to respond to FAA requirements as stated above and to respond to the public comments received in response to the original NPRM. This report will form the core of the FAA project to revise the regulation [Part 65] specifying the requirements for technician certification.

Regulatory Link: Regulatory FAR Part 65; AVR Performance Plan(2000) Initiative 35, NTSB Recommendation A-89-56/FAA National Aging Aircraft Program Plan

Requirement ID: 176

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Development of Standards for AMT Certification Training Using Distance Learning

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: The efficiency and effectiveness of the knowledge delivery is being lost. AMT training is limited by regulation to the use of traditional delivery methods. This has contributed to the decline of persons entering the aviation maintenance career. High school students cannot obtain aviation training until graduation, unlike other careers such as automotive maintenance, which provides introductory training to high school students in a manner consistent with high school scheduling requirements. The early introduction into the automotive industry creates interest and motivates students to seek automotive careers. Authorized distance learning may also provide military personnel with the ability to complete AMT training prior to discharge allowing for a faster, more efficient transition in to civilian careers.

Background: Models shall form the basis for curriculum certification guidance to be utilized by AMT training providers and FAA Airworthiness Inspectors

Output: Development of standards for the delivery of AMT certificate training using distance-learning technology. This will lead to the development of distance learning standard (Eval & Validate)

Regulatory Link: Regulatory FAR Part 147; AVR Performance Plan (2000) Initiative 35, NTSB Recommendation A-89-56/FAA National Aging Aircraft Program Plan

Requirement ID: 177

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Evaluation of the Integrated AMT/AMT-T Curriculum
Alternative Method Implementation and Assessment

Funded Requirement:

- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Legislation mandates research on future training requirements on projected changes in regulatory requirements for aircraft maintenance and power plant licenses

Background: Develop, implement, and assess the integrated curriculum using alternative training methodologies for AMT technology skill transfer and application that demonstrates student performance-outcome based on curriculum, such as team-building, human factors, error control and analysis, computer and technical material, multimedia based educational/learning modules for active learning to test whether curriculum meets educational objectives and student performance objectives

Output: Development of model program that can be replicated in other technical colleges

Regulatory Link: Congressional Mandate/Agreement between ARA-2 and Sen. Hollings; Project completion after 2001

Requirement ID: 182

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Evaluation of US Military AMT Training and Experience Applicability to Training, Qualification, and Certification Requirements

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Determine applicability of military training and experience based upon FAA requirements. Identification and development of these requirements necessary to bridge the differences for training military AMTs. The objective of this research is to develop an articulation document which will allow recognition of military aviation maintenance training and experience toward the award of FAA A&P certification. Any discrepancies that may exist between the military training and the FAR Parts 65 and 147 requirements will be identified

Background: Develop standards that will provide the means to establish a validation process by which the FAA can establish certification credit for military training, qualifications and experience

Output: Guidance and curricula guidelines for military to administer the appropriate AMT written oral and practical examination, validation of qualified, competent personnel

Regulatory Link: Regulatory/FAA/DoD/DOL Interagency Task Force (Pentagon Interest/AOA) /FAA National Aging Aircraft Program Plan/Project completed

Requirement ID: 183

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Application of Human Factors Interventions to Improve Inspector Performance

Funded Requirement:

- FY01: Yes
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: There is no industry-wide standard or benchmark for inspector training. Task analysis of aircraft inspection and maintenance reveal that individual differences among inspectors is one of the leading factors that have the greatest impact on inspector performance

Background: Evaluation and validation studies that focus on the impact of inspector training programs in minimizing inspector errors and standardizing the inspection training process

Output: An industry-wide benchmark inspection aid for inspector training

Regulatory Link: AVR Performance Plan (2000) NTSB Recommendation A-97-76/Report to Congress/FAA National Aging Aircraft Program Plan/ Project Completion after 2001

Requirement ID: 184

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Human Factors Best Practices in Engine Inspection

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: This research is necessary to ensure that the inspection of engine components, particularly rotating components, reaches the highest possible level of reliability. Incidents such as Sioux City DC-10 crash and the Pensacola MD-80 damage have shown that engine component inspection is not perfectly reliable and that the human element in the inspection system is primary cause of concern.

Background: Development of improved training schemes and procedures for a variety of engine inspection tasks to reduce the overall incidence of inspection error for critical components.

Output: Report with detailed human factors analysis and recommendations for improvement of inspection reliability of engine components.

Regulatory Link: AVR Performance Plan (2000) Initiative 1, NTSB Recommendation 98-1/ FAA National Aging Aircraft Program Plan/supportive of AFS-300/ANE-105/AFS-600 Initiative

Requirement ID: 185

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Development of Handbook of Human Factors in Airframe and Engine Inspection Reliability

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: This research is necessary to ensure that the aviation inspection reaches the highest possible level of reliability. Incidents such as Aloha B-737 failure, the Sioux City DC-10 crash and the Pensacola MD-80 damage have shown that inspection is not always reliable and that the human element in the inspection system is a primary cause of concern. Inspection managers and inspectors themselves are often unaware of the importance of human factors, and thus do not design inspection facilities, training systems or procedures to minimize the negative impact of human performance on inspection reliability.

Background: Development of handbook applying what is known about human factors in inspection to improve engine and airframe reliability.

Output: Handbook of human factors in aviation inspection to provide a single source for industry. Topics will include design of training programs, design of inspection equipment, the inspection environment, and the design of operating procedures using human factors knowledge and data.

Regulatory Link: AVR Performance Plan (2000) Initiative 1, NTSB Recommendation 98-1/FAA National Aging Aircraft Program Plan/supportive of AFS-300/ANE-105/AFS-600 Initiative

Requirement ID: 186

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: General Aviation Maintenance Human Factors: Taxonomy of Human Error At-Risk Conditions in General Aviation Maintenance

Funded Requirement:

- FY01: Yes (CAMI in-house)
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Error in General Aviation (GA) maintenance can be the result of maintainer acts, working conditions, maintainer conditions, supervisory conditions or even organizational climate. Variations in work settings from single person shops to relatively large maintenance facilities present unique challenges for GA maintenance human factors research. A description of conditions conducive to errors is needed to provide a systematic framework of research.

Background: A taxonomy to support accident / incident investigation, and assessment of the individual, organizational and training issues that influence the performance of GA maintenance personnel.

Output: Development of a model that can be used across GA maintenance shops and flight lines to identify human factors concerning at risk conditions associated with GA maintenance incidents.

Regulatory Link: CAMI in-house resources

Requirement ID: 190

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Demonstration Project for AMT Training Delivered Using Distance Learning Technology; FAR 147 Certification Model; Structured Experience Certification Model; AMT Recurrent Training Model

“Unfunded Requirement for FY02 & FY03 (pop up)”

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: Over the past 4 years the Aviation Maintenance Technician certification process, training requirements and delivery methods have been researched to develop better methods and processes. This research includes the development of new FAR 147 training requirements, a Structured Experience certification process, and the study of new methods for the delivery of AMT training utilizing distance education. A consistent outcome of this research is that it is very difficult to move from the status quo. If AMT training is to advance and utilize these new regulatory possibilities it will require a proven demonstration model for training providers to emulate. Additionally, using delivery methods that cross FAA regional and FSDO boundaries will require a single, uniform, tested process for training curriculum approval and the monitoring of student outcomes and instructional quality. This research initiative will address these issues and develop the pilot models that can serve as an example for both training providers and the FAA.

Background:

Output: Data or documentation required to support development of advisory circulars, rulemaking efforts, and changes or improvements to operations, maintenance or training procedures. The outcome of this project will be to provide the FAA and AMT training providers with a proven model for the delivery of training programs using distance learning technology for FAR 147 training, Structured Experience Certification training and AMT/IA recurrent training. This project will provide the data and documentation for advisory circulars, rulemaking, and FAA Airworthiness Inspectors Handbook.

Regulatory Link: AFS-300 FAR 147 Rulemaking, FAR 65 (AMT experience requirement) Rulemaking, Enhanced AMT training and safety, NTSB recommendation A-89-56, AVR Performance Plan, and FAA Safer Skies Agenda.

Requirement ID: 191

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components

“Unfunded Requirement, FY02-FY03”

Funded Requirement:

- FY01: No
- FY02: Yes
- FY03: Yes
- FY04: No

Requirement Statement: At a minimum, the goal of this project is to determine the proper standards to be employed in the visual acuity testing of persons inspecting aircraft and aircraft components. This material will then be set forth in an Advisory Circular or eventually be included as an amendment to the Federal Aviation Regulations. This project would involve, as a minimum, the following:

1. Establish the standard to be used for both near and far vision tests.
2. Establish the standard to be used for testing color perception.
3. Determine who will be required to meet these minimum standards for performance of their job function.
4. Determine the time interval when vision tests will be administered.
5. Establish written procedures to provide guidance to organizations that will need to setup programs for administering and documenting the visual acuity examinations.
6. Determine if these standards should be included in an Advisory Circular or as an amendment to the Federal Aviation Regulations.

Background: Part 67 of the Federal Aviation Regulations provides requirements for visual acuity testing for aircraft pilots for first, second and third class medical certificates. There currently is no requirement to assure that persons performing maintenance or inspection of aircraft meet a minimally acceptable vision requirement. Various programs for the certification of persons performing Nondestructive Testing require vision examinations prior to certification. These requirements are neither uniform nor standard throughout the industry. There currently is no requirement for a person performing visual inspections to be tested for visual acuity or color perception. There have been several aircraft accidents where large cracks and/or corrosion were not detected during visual inspections. The National Transportation Safety Board (NTSB) has cited the failure to visually detect detectable cracks as the probable cause of these accidents. Examples of these are as follows:

NTSB 98/01, Aircraft Accident Report, Uncontained engine failure, Delta Airlines, Flight 1288, McDonnell Douglas MD-88, N927DA, Pensacola, Florida, July 6, 1996. A crack with a total surface length of 1.36 inch in the front compressor hub of a Pratt & Whitney JT8-219 engine, was not detected during Visual and Fluorescent penetrant inspections.

NTSB 09-06, United Airlines Flight 232, McDonnell Douglas DC10-10, Sioux Gateway Airport, Sioux City, Iowa, July 19, 1989. A crack with a total surface length of 0.498 inch in the stage 1 fan disk in the no. 2 CF6-6 engine was not detected during Visual and Fluorescent penetrant inspections. The NTSB determined, based on a count of the fatigue striations that at least two inspections had been accomplished after the crack had reached a detectable length.

NTSB 89/03, Aloha Airlines, Flight 243, Boeing 737-200, N73711, near Maui, Hawaii, April 28, 1988. The NTSB determined that the cause of this accident was the failure of the Aloha Airlines maintenance program to detect the presence of significant disbonding and fatigue damage which ultimately led to the failure of a lap joint at stringer 10L. This damage should have been detected visually and in fact, a passenger boarding the aircraft visually saw cracks that were not detected by Aloha mechanics.

Output: The desired output is an acceptable standard by which visual acuity testing will be performed and documented for those persons inspecting aircraft and aircraft components.

The desired outcome is to initiate a research project to determine visual acuity requirements for persons maintaining and inspecting aircraft and aircraft components to maintain an acceptable level of safety. Over fifty percent of all Advisory Directives issued, require inspection, yet there is no standard to determine how well or if an inspector can see.

Regulatory Link: The National Transportation Safety Board (NTSB) has cited the failure to visually detect detectable cracks as the probable cause of these accidents.

Requirement ID: 192

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Assessment of FAR PART 145.159 Repair Stations - Training Requirements for maintenance production and supervisory employees with Summary Recommendations

“Unfunded Requirement for FY02 & FY03 (pop up)”

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: FAR PART 145 has been significantly revised. One of the major revisions is in the Training Requirements section. The NPRM for the 145 changes states: To provide time for repair stations to develop their training programs, this final rule provides that beginning 2 years after the effective date of the rule, each applicant for a repair station certificate, must submit a training program for approval by the FAA. It also states: A repair station certificated before that date [the effective date of the rule plus 2 years] must submit its training program for approval on the last day of the month in which its certificate was issued. Training requirements have evolved to ensure continuing safety in the international Repair Station maintenance work environment. This project shall provide the research and review to characterize the current state of training at Repair Stations and based upon evaluation and industry input, define a direction for the evolution of the necessary training requirements to ensure continuing safety. This information will be used by FAA to assist them in developing training requirements, guidance materials, and Aviation Safety Inspector Handbook information.

Background: Sponsor Need Description: A final report on the results of the evaluative research conducted on FAR PART 145 training requirements, that includes conclusions and recommendations on which the FAA may base guidance and Aviation Safety Inspector Handbook information.

Output: The outcome will be an objective report based upon research conducted with industry and FAA input. The desired outcome will be guidance materials that will assist industry in building practical, objective, training programs that meets both the needs of industry and the safety requirements of the FAA. The FAA will have substantive information on which to base guidance materials and ASI Handbook information.

Regulatory Link:

Requirement ID: 193

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Assessment of Requirements for and Availability of Qualified Aviation Maintenance Technicians by 2005

“Unfunded Requirement for FY02 & FY03 (pop up)”

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: To conduct an assessment of requirements for and availability of qualified aviation maintenance technicians for the year 2005. The Project Report will provide detailed information on findings, include conclusions based upon those findings, and will contain recommendations for the aviation industry and the FAA.

Background: The year 2001 has swung a very unusual pendulum with respect to personnel requirements. At the outset of the year the entire aviation maintenance community was forecasting a severe shortage of AMTs (aviation maintenance technicians). A combination of terrorist attacks, along with a pending economic downturn, has resulted in significant reductions in the aviation maintenance workforce. In this cyclic trend of maintenance personnel current conditions suggest that there is no longer a shortage. The result is that more qualified technicians will likely permanently leave aviation for other career fields and that schools will also have lower enrollment, in fact additional schools may completely eliminate AMT training. When the industry inevitably returns to full strength, as in the past, the shortage occurs. The supply of qualified AMTs must be developed to meet the inevitable return and continued growth of the aviation transportation system. This study will review the current status, project personnel requirements and suggest means and methods to providing a supply of AMTs to meet forecast demand. GAO report.

Output: This study must position government, industry, and schools to fully understand the requirements for maintenance personnel and design training and certification programs accordingly.

Regulatory Link:

Requirement ID: 194

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Increase Reliability of Wiring Inspection

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: The proposed research directly benefits the Aging Systems initiatives in the Federal Aviation Administration (FAA) and Air Transport Association (ATA) aimed at improving the safety of transport aircraft wiring systems. The end point of all rule-making and technology is the inspector who must perform wiring systems inspections with high reliability. Any techniques that enhance the reliability and predictability of inspection performance will increase public safety and ultimately help operators in more efficient use of inspection resources. There is a nationally expressed need to translate the rulemaking activity into effective inspection. This proposal addresses issues of inspector training, factors affecting reliability and help in implementation of research findings. The work builds on a continuous program of involvement with human factors issues in airframe and engine inspection dating back to the Aloha incident of 1998. The proposal covers four Research Objectives:

1. Build on the experience of detailed analyses of a variety of inspection techniques to better characterize wiring inspection and its human factors implications for reliability.
2. Examine experimentally the factors expected to enhance or degrade visual and NDI inspection of wiring systems. This will enable the design of job aids, training or modified inspection intervals depending on the specific factors concerning the defect condition and the environment in which that condition is embedded.
3. Determine the extent to which correlated cues can be used to enhance visual inspection of wiring systems. The Intrusive Inspection report showed that while some defect conditions are not directly detectable, other manifestations correlated what those conditions may be. This determination will form the basis of model training programs and job aids to improve detection reliability.
4. Provide practical best practices for enhancing wiring inspection to cover training, job aids, environment design and documentation design and test selected practices for both effectiveness and acceptability.

Background: The National Transportation Safety Board (NTSB), from its analysis of the TWA 800 accident (Safety Recommendations, Sept. 2000), made a number of recommendations concerning wiring safety, including

"The need for improved training of maintenance personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions."

In addition, the FAA and ATA have made extensive recommendations on improved wiring inspection as parts of the Aging Transport Systems Rulemaking Advisory Committee (ASTRAC) and the issuance of ATA Specification 117 Wiring Maintenance Practices/Guidelines. Finally, the Assistant Inspector General for Auditing (USDOT) in testimony on October 5, 2000 noted that

"... it is uncertain when revised maintenance programs, new training programs, and especially new technology can be implemented."

Output: From this activity will come three specific sets of outcomes as noted in 5 above. First, job aids, training or modified inspection intervals will be specified depending on the specific factors concerning the defect condition and the environment in which that condition is embedded. Second, model training programs and job aids to improve detection reliability will be developed. Finally, the project will provide validated practical best practices for enhancing wiring inspection to cover training, job aids, environment design and documentation.

Regulatory Link: Initiative 8 under Performance Goal 1 of FY 1999 AVR Performance Plan calls for the FAA to "establish requirements for training aids in wiring installation practices for certification engineers and designees"

Requirement ID: 195

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Development of Best Practices for Confined Space Work

Funded Requirement:

- FY01: No
- FY02: No
- FY03: No
- FY04: No

Requirement Statement: In order for the FAA to provide the public with continuing safe, reliable air transportation system it is important to have a sound aircraft inspection and maintenance system. The inspection/maintenance system is a complex one with many interrelated human and machine components. Recognizing this, the FAA has pursued human factors research. In the maintenance arena this research has focused on the aircraft inspector and the aircraft maintenance technician (AMT). Since it is difficult to eliminate errors altogether, continuing emphasis must be placed on developing interventions to make the inspection/maintenance system more reliable and/or more error tolerant. Recent NTSB reports, accidents have indicated that confined space work has the potential to cause increased damage to critical components/inferior inspection work/poor maintenance repair (e.g., wiring damage), increased risk to human health, or all the above. If we are to ensure that confined space work is performed effectively, efficiently and reliably over time, it is critical that we identify appropriate human-factors interventions that will improve confined space work leading to reduced errors and improved safety. The specific objectives of this research are three-fold:

- analyze current human factors practices as they deal with working in confined spaces at aircraft maintenance facilities and identify human factors interventions to eliminate errors and identify safe work practices,
- research best practices by outlining a model program for confined space work that would improve safety, quality of work and human well being by standardizing confined space work for use by the aircraft maintenance industry, and
- identify /demonstrate /develop specific tools/interventions to support the confined space model program.

The research directly addresses issues that are critical to aviation safety as outlined in the NTSB recommendations, are critical to the FAA, and the general public. To ensure that the research is relevant and addresses the needs of the aviation community, it will be pursued with aviation partners that include airlines and aircraft maintenance organizations.

Background: Task analyses of aircraft maintenance activity have shown it to be a complex system consisting of several interrelated human and machine components. The linchpin of this system, however, is the human. Recognizing this, the Federal Aviation Administration (FAA) has pursued human factors related research. In the maintenance arena the research has focused on the mechanic and the aircraft inspector. This maintenance includes scheduling the repair of known problems; replacing items after a certain air time, number of cycles, or calendar time; repairing defects discovered previously, for example from reports logged by pilot and crew or from line inspection, or items deferred from previous maintenance; and performing scheduled repairs. Task analysis of maintenance activities has revealed aircraft inspection and maintenance to be a complex activity requiring above average coordination, communication and cooperation between various personnel to be effective and efficient. This activity is further compounded because a significant portion of the work done by inspectors and maintenance crew has to be performed in limited or confined spaces (e.g., aircraft fuel tank inspection and maintenance work). Previous research in confined space work has shown that working in confined space has the potential of causing: increased damage to critical components/inferior inspection work/poor maintenance repair (e.g., wiring damage), increased risk to human health (Vendetti and Allen, 2000; FAA Aviation News), or all the above. A recent NTSB safety recommendation (A –00-105 through 108) developed in light of the July 1996 TWA 800 Boeing 747-131, N39119 crash referred to the issue of confined space work specifically stating the “need for improved training of maintenance personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions.” Thus it is seen that if we are to ensure that confined space work activity is performed safely, effectively and efficiently it is critical that we identify strategies to improve confined space work and provide maintenance personnel with appropriate tools/training in performing confined space work. In response to this need this research will look at confined space work to identify human factor interventions that focuses on improving worker safety, and on improving maintenance and inspection processes.

The rationale and need for this research can be summed up as follows:

- In aircraft maintenance, confined space work constitutes an area with potential for a large number of maintenance errors and safety violations (see NTSB reports and recommendations)
- Errors during confined space work have been documented. Confined space work results in increased stress on the human with potential for causing injury (to the human, equipment, critical aircraft components and all the above). Confined space work conducted as part of inspection, repair and maintenance procedures for fuel tanks pose numerous potential dangers, including fire, explosion, toxic chemical exposure, and oxygen deficiency or enrichment conditions.
- Evidence consists of reports of safety violations, incorrect and or improper maintenance/inspection.

- Many repair facilities have unclear procedures for confined space work. Even if general guidelines exist, they are not communicated and are not strictly adhered to.

Output: The research will help identify strategies to improve confined space work and provide maintenance personnel with appropriate tools/training in performing confined space work. In response to this need this research will look at confined space work to identify human factor interventions that focuses on improving worker safety, and on improving maintenance and inspection processes. The research will provide the following deliverables for industry use:

1. Model Confined Space Program: outline a detailed program for confined space work that can be implemented by the aircraft maintenance industry. This will serve as a model program for the aircraft maintenance industry, identifying best practices in conducting confined space work. Specifically the program will address the following issues as they relate to: definitions, permits, certification, duties and responsibilities, program management-accountability and responsibility, organizational support, training, information dissemination, procedures – safety practices, implementation, entry/exit, equipment support, purchasing, and other relevant issues)
2. Handbook of Confined Space Work for the Aircraft Maintenance Industry.
3. Tools for Confined Space Work: Outline Training and Awareness programs and workshops for promoting best practices as they relate to confined space work in the aircraft maintenance environment.
4. Research Dissemination: The results of this research will be disseminated to the aviation community via a number of avenues. These include, but are not restricted to, workshops (FAA sponsored), scholastic publications, presentations at professional conferences (e.g., SAE sponsored conference, Aviation Psychology Conference, and FAA sponsored conferences) and through publications on the internet. In particular, the results of the research will be regularly conveyed to the team partners through regular debriefing meetings. Most importantly the results of this research will lead to improvements in inspection/maintenance operations and new training procedures.

Regulatory Link:

1. Previous reports and accidents have revealed that adherence to procedures, awareness, training and organizational support for confined space work is often lacking. Often, there is no detailed program for performing work in confined spaces. Moreover, when one exists employees are not trained, procedures to work are not followed or there exists a lack of awareness. This has resulted in recent incidences and accidents that have been attributed to confined space work. In light of this situation it is critical that research be conducted which will address the issue of improving confined space work by identifying specific interventions.

2. This research will directly support recent NTSB recommendations in light of the July 12, 1996 crash of TWA flight 800, Boeing 747-131, N93119 which specifically tasks the FAA and specifically the Aging Transport Systems Rulemaking Advisory Committee with identifying strategies to improve confined space work to reduce incidences of human error (potential wiring damages, damage to critical components) (see A-00-106, A-00-107) and improve safety by looking at training of maintenance personnel and by developing procedures. Moreover the research, also supports earlier NTSB recommendation A-97-70 (A-97-70 Include, in its development and approval of air carrier maintenance procedures and programs, explicit consideration of human factors issues, including training, procedures development, redundancy, supervision, and the work environment, to improve the performance of personnel and their adherence to procedures) which was issued as a result of NTSB's investigation of an accident on May 11, 1996, involving a McDonnell Douglas DC-9-32, N904VJ, that crashed into the Everglades swamp shortly after takeoff from Miami International Airport, Miami, Florida. The airplane was operated by ValuJet Airlines, Inc., as ValuJet Flight 592.
3. Congressional/Other Interests: This research has the potential to improve confined space work (improves worker safety, reduces errors leading to -- more effective and efficient maintenance). All of which will have a positive impact on quality of maintenance and airline safety -- are of interest to Congress, FAA, NTSB, the airline industry and the general public.

Requirement ID: 216

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Evaluation of Broadband Applications to Aircraft Maintenance Safety

“FY04 Task or Project Description”

Funded Requirement:

- FY01: No
- FY02: Yes
- FY03: Yes
- FY04: Yes

Requirement Statement: The application of broadband technologies has significant impact on maintenance practices and on the positive potential to safety. Broadband applications run the gamut from digital documentation to electronic signature. The emerging technologies include, but are not limited to: training-on-demand, video-on demand, wireless access to technical documentation and much more. This research shall review the emerging technologies to the extent to which such technologies are impacting safety. This research shall also determine the extent to which human-centered design contributes to the successful application of these broadband technologies.

Background: Identification of emerging broadband applications to maintenance. Identification of safety impact of broadband technology. Assessment of positive and potential negative impact of broadband applications for maintenance technicians. An understanding of the integration between training and job-aiding as broadband technology use in maintenance environments.

Output: Overview of the state-of-the-art of broadband applications to maintenance. Identification of safety impact broadband applications for maintenance technicians. An understanding of the integration between training and job-aiding as broadband technology using maintenance environments.

Regulatory Link:

Requirement ID: 217

Sponsor Organization: AFS

POC: Les Vipond

Requirement Title: Using Technology to Support Inspection Training: In the General Aviation Industry

“FY04 Task or Project Description”

Funded Requirement:

- FY01: No
- FY02: Yes
- FY03: No
- FY04: No

Requirement Statement: to demonstrate how advanced technology can be used for inspection training and reducing errors for the general aviation industry.

Background: Reduce inspection errors and improve GA inspection performance, ultimately impacting safety and reliability of GA aircraft inspection and GA maintenance operations.

- Standardize the GA inspection training process providing an industry-wide benchmark for inspection training.
- Alleviate problems inherent to OJT and can be combined with existing GA training programs to facilitate consistency in inspection training, provide adaptive training and support record keeping and performance monitoring.

Output: This research will provide the general aviation industry with a benchmark for inspector training. Evaluation and validation studies will be delivered that focus on the impact of inspector training programs in minimizing inspector errors and standardizing the inspection training process.

Regulatory Link:

Appendix III

Human Factors Aviation Maintenance Fiscal Year Project Planning

FY02 Funded Projects

FY03 Proposed Projects

FY04 Proposed Projects

FY02 Aviation Maintenance
Proposed Projects (~ \$1,000,000)

Task	Performer	Deliverable	Requirement #
Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components	NASA/CAMI	an acceptable standard by which visual acuity testing will be performed and documented for those persons inspecting aircraft and aircraft components.	191
Evaluation of Broadband Applications to Maintenance Safety	TBD	Overview of the state-of-the-art of broadband applications to maintenance. Identification of safety impact broadband applications for maintenance technicians. An understanding of the integration between training and job-aiding as broadband technology using maintenance environments.	216
Using Technology to Support Inspection Training in Corporate, Regional, and GA	TBD	This research will provide the general aviation industry with a benchmark for inspector training. Evaluation and validation studies will be delivered that focus on the impact of inspector training programs in minimizing inspector errors and standardizing the inspection training process.	217
Determine whether language barriers result in maintenance deficiencies	TBD		"Secretary of Transportation pop up"
Amateur built aircraft	TBD		"pop up"

**FY03 Aviation Maintenance
Proposed Projects**

Task	Performer	Deliverable	Requirement
Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components	NASA/CAMI	an acceptable standard by which visual acuity testing will be performed and documented for those persons inspecting aircraft and aircraft components.	191
Evaluation of Broadband Applications to Maintenance Safety	TBD	Overview of the state-of-the-art of broadband applications to maintenance. Identification of safety impact broadband applications for maintenance technicians. An understanding of the integration between training and job-aiding as broadband technology using maintenance environments.	216
Using Technology to Support Inspection Training in Corporate, Regional, and GA	TBD	This research will provide the general aviation industry with a benchmark for inspector training. Evaluation and validation studies will be delivered that focus on the impact of inspector training programs in minimizing inspector errors and standardizing the inspection training process.	217
Determine whether language barriers result in maintenance deficiencies	TBD		“Secretary of Transportation pop up”
Amateur built aircraft	TBD		“pop up”
Assessment of Requirements for and Availability of Qualified Aviation Maintenance Technicians by 2005	TBD	This study must position government, industry, and schools to fully understand the requirements for maintenance personnel and design training and certification programs accordingly.	193

FY04 Aviation Maintenance Proposed Projects

Task	Performer	Deliverable	Requirement
Evaluation of Broadband Applications to Maintenance Safety	TBD	Overview of the state-of-the-art of broadband applications to maintenance. Identification of safety impact broadband applications for maintenance technicians. An understanding of the integration between training and job-aiding as broadband technology using maintenance environments.	216
Using Technology to Support Inspection Training in Corporate, Regional, and GA	TBD	This research will provide the general aviation industry with a benchmark for inspector training. Evaluation and validation studies will be delivered that focus on the impact of inspector training programs in minimizing inspector errors and standardizing the inspection training process.	217
Determine whether language barriers result in maintenance deficiencies	TBD		“Secretary of Transportation pop up”
Amateur built aircraft	TBD		“pop up”
Assessment of Requirements for and Availability of Qualified Aviation Maintenance Technicians by 2005	TBD	This study must position government, industry, and schools to fully understand the requirements for maintenance personnel and design training and certification programs accordingly.	193